*Update on demonstrator considerations in context of MUC

nuSTORM -- general meeting 2021/08/09

Rui Franqueira Ximenes SY-STI-TCD
(on behalf of many other)

*Mostly as in the 2nd MUC Community meeting

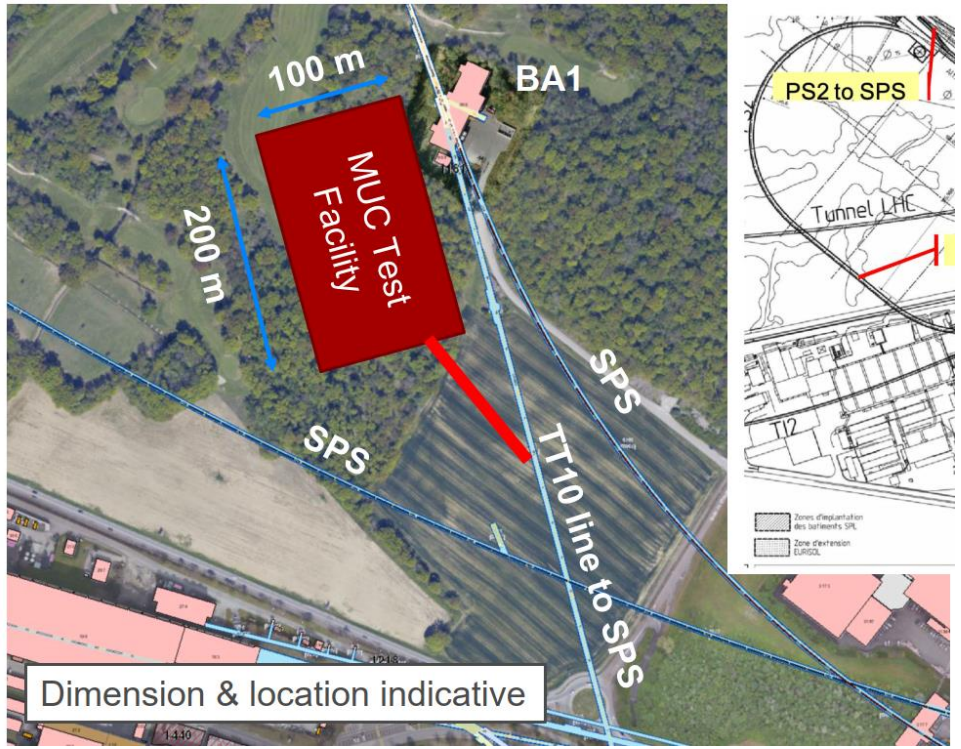
Outline

1. Intro
2. Layout ideas
3. Conceptual layout of MUC
4. Conclusions

Intro

TT10 line option (recap)

- First ideas proposed by Marco C. in the 1st Community meeting. **TT10 line option seen as most attractive** (Roberto L. presentation).
  - O(80kW) should be easily feasible by going sufficiently underground.
  - 4 MW does not appear to be a showstopper in this layout, but detailed studies will have to be performed.
  - Future upgrades towards a collider and HP-SPL should be compatible with this layout.
  - **Experience** with other facilities available
  - Important to collect all **requirements** at this stage in order to be able to provide a first cost estimate by end of 2021 as requested by the study



Layout

Layout components of the Demonstrator:

- Target & Horn (first stage) and potentially superconducting solenoid at a later stage
- Momentum selection chicane
- Collimation & diagnostics area
- Muon Cooling area
- Downstream diagnostics area

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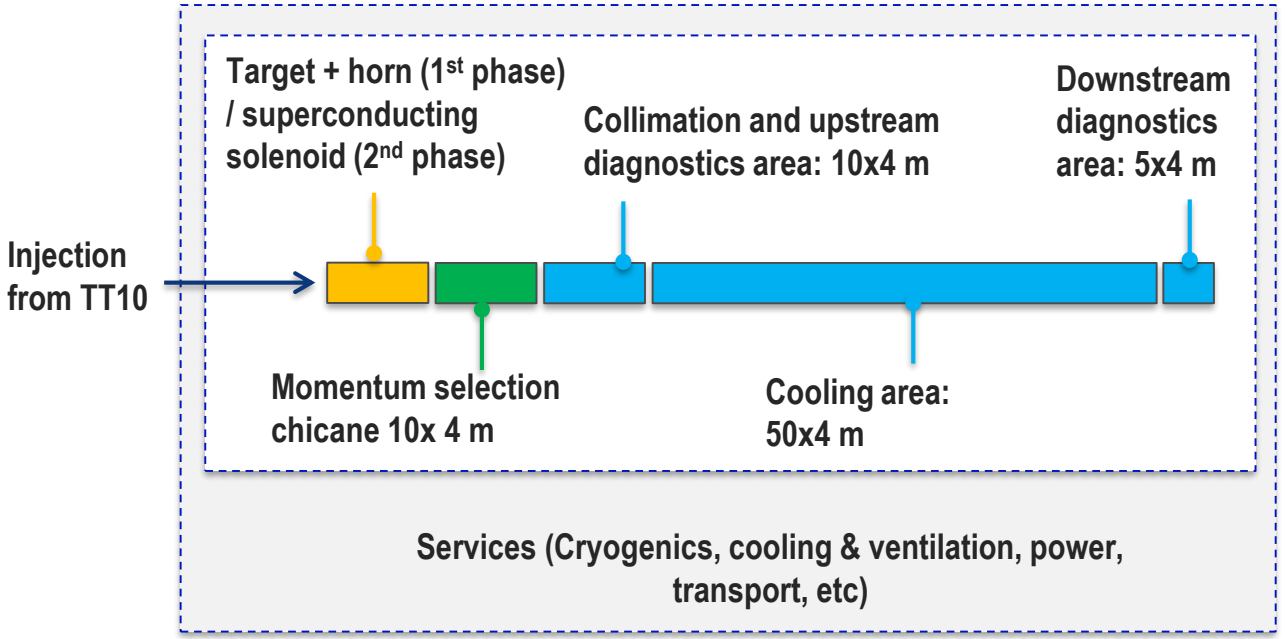
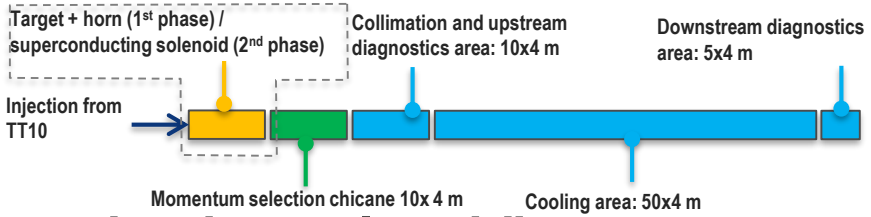
- Service areas (Cooling & ventilation, cryogenics, power, transport, etc…)
- Radioactive storage
- *Branch to other experiments ?*
- … other??



*Indicative dimensions by C. Rogers

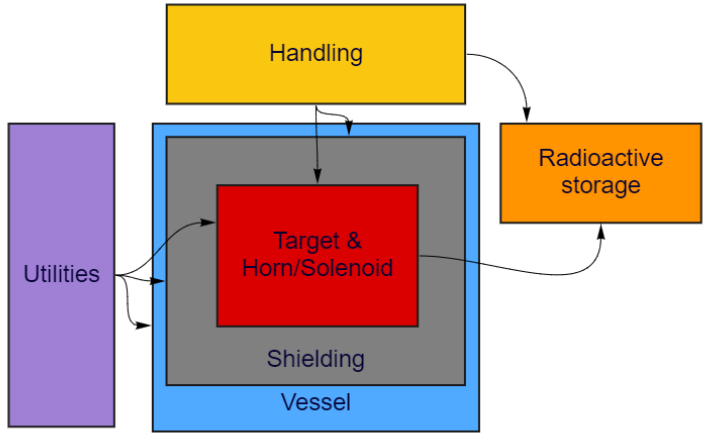
Layout ideas

Layout ideas



Target + Horn (and/or superconducting solenoid)

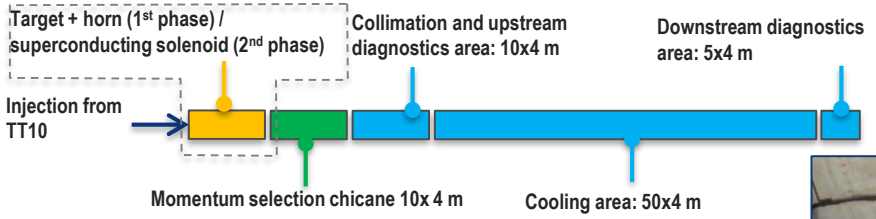
- Target + Horn length (O) 5 m. (What volume with solenoid?)
- Cooling (Target + Horn) and power (Horn) supplies required
- High activation / radiation levels (specially for 4 MW case):



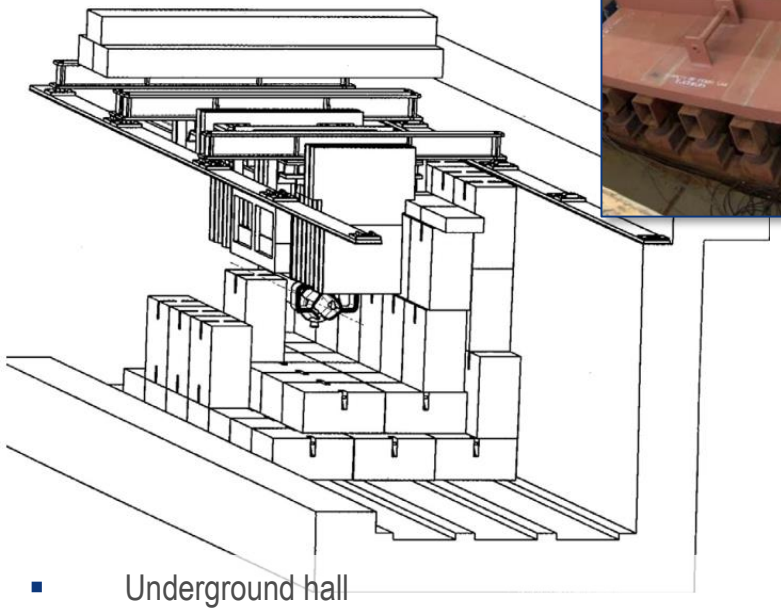
- Service rooms for power & Cooling Ventilation
- Shielding (& space for it)
- Vessel
- Handling solutions.
- Radioactive storage in the surrounding area
- Access from surface

All of these set requirements for the layout

Layout ideas



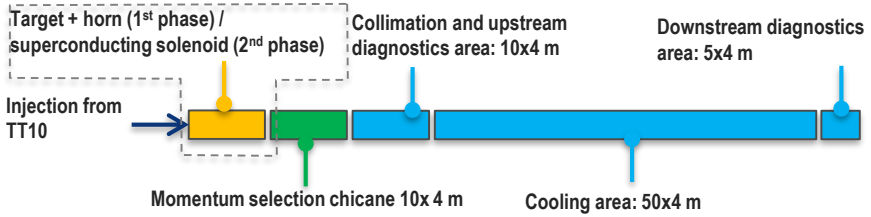
Target + Horn (and/or superconducting solenoid) - NuMI @ FNAL



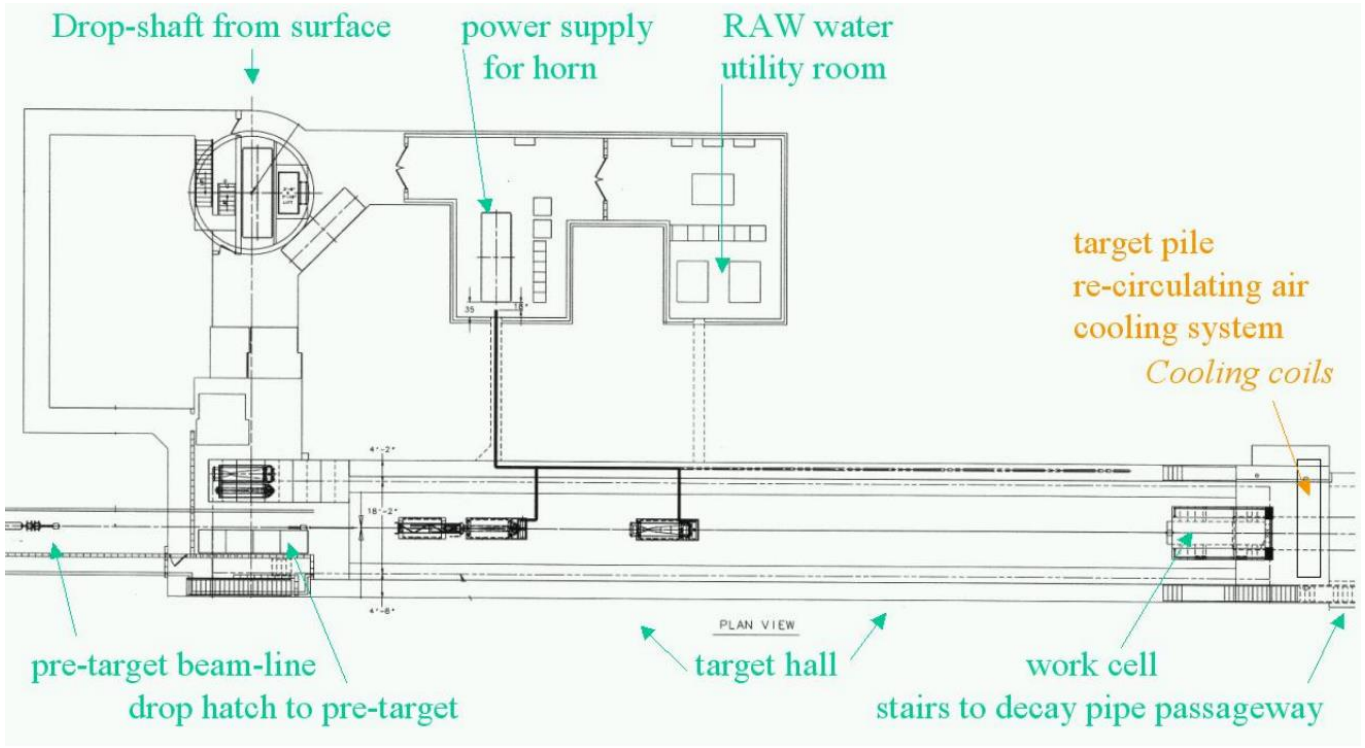
- Underground hall
- Vertical Handling
- Equipment by modules
- Module is a suspended frame w/ equipment + shielding + utilities connections

Yun He, NuMI Neutrino Beam Operations and Megawatt Upgrade, NUFACT2019

Layout ideas



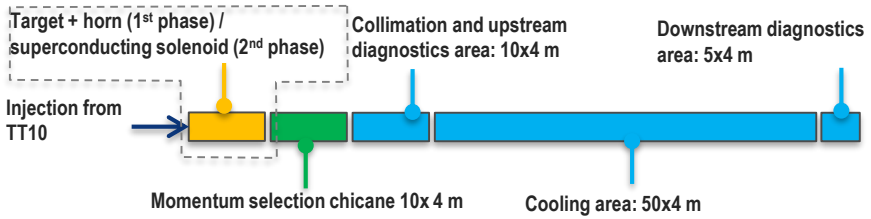
Target + Horn (and/or superconducting solenoid) - NuMI @ FNAL



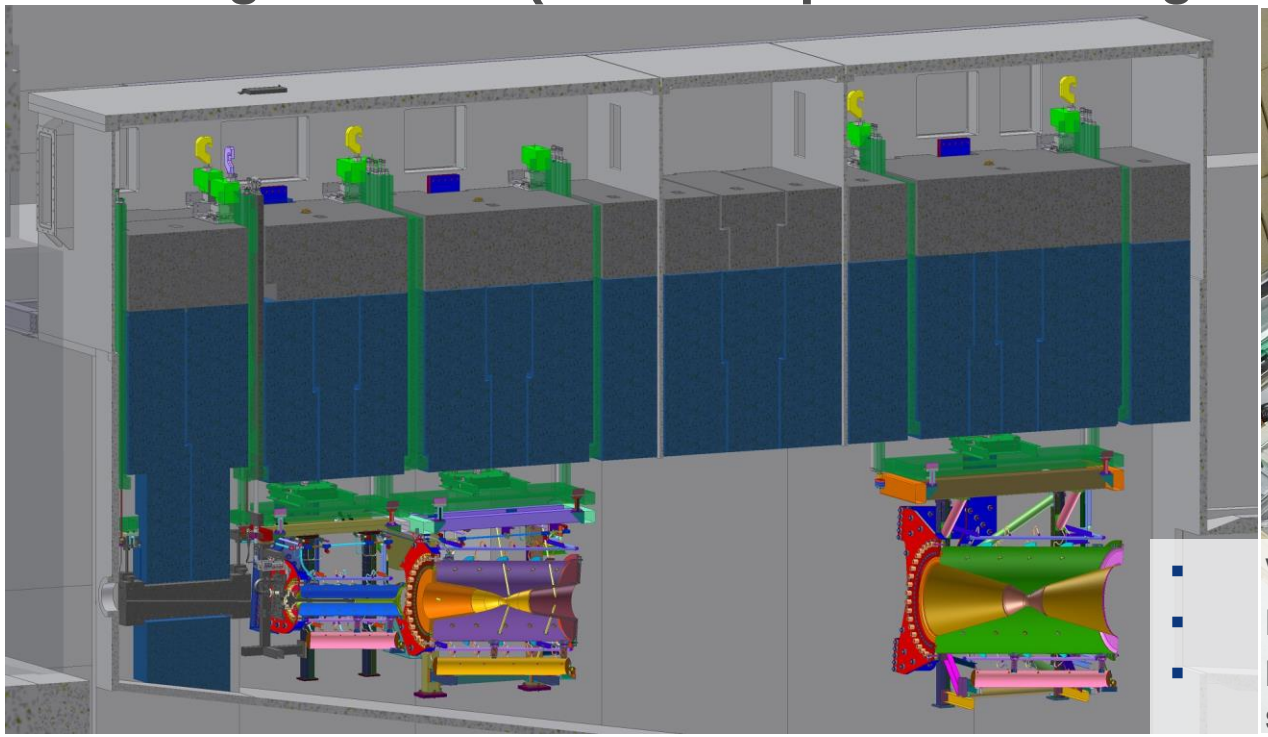
- Utilities room on a separate gallery parallel to the beamline
- Shielding between beam line access shaft

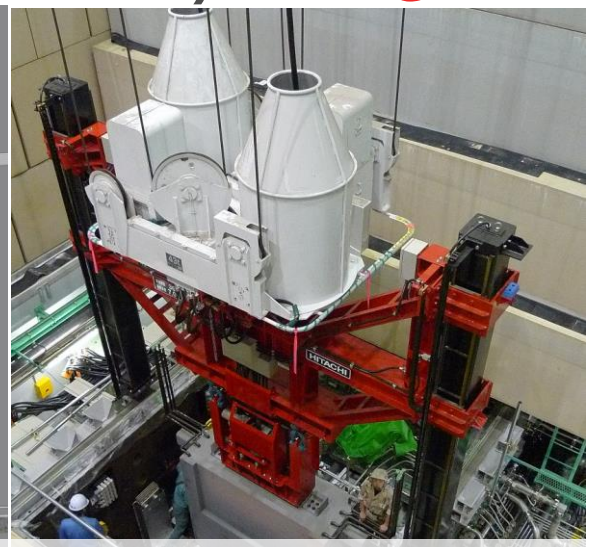
Yun He, NuMI Neutrino Beam Operations and Megawatt Upgrade, NUFACT2019

Layout ideas



Target + Horn (and/or superconducting solenoid) - T2K @ J-PARC



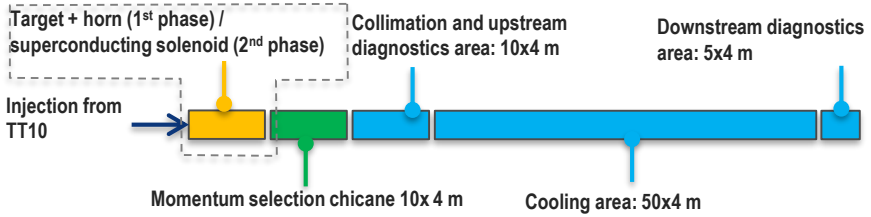


- Vertical Handling
- Equipment by modules
- Module is a suspended frame w/ equipment + shielding + utilities connections
- Installation by steps
- Placed inside a He vessel

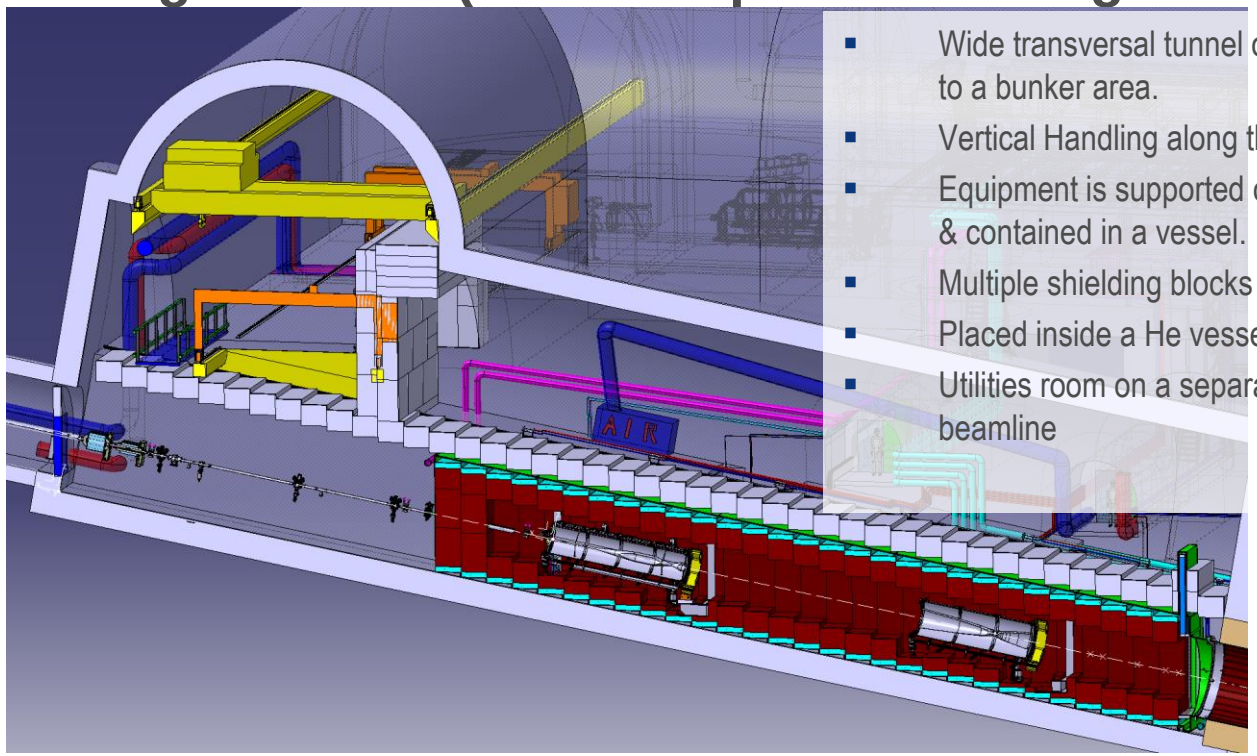
https://t2k.org/docs/photos/beamline

https://doi.org/10.1016/j.nima.2011.06.067

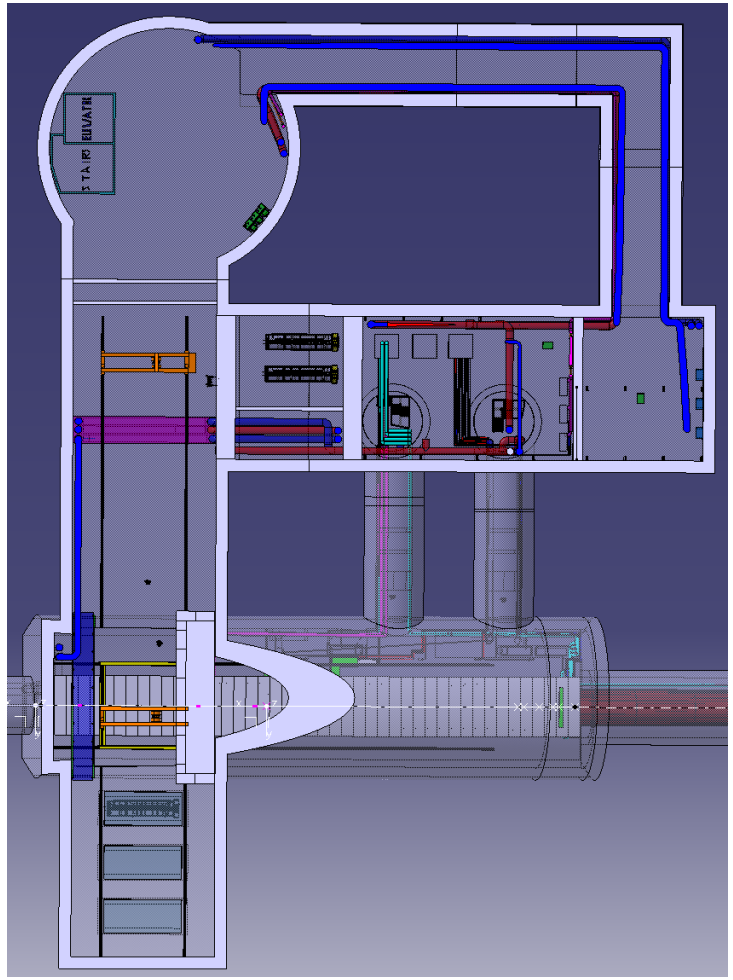
Layout ideas



Target + Horn (and/or superconducting solenoid) - CN2PY

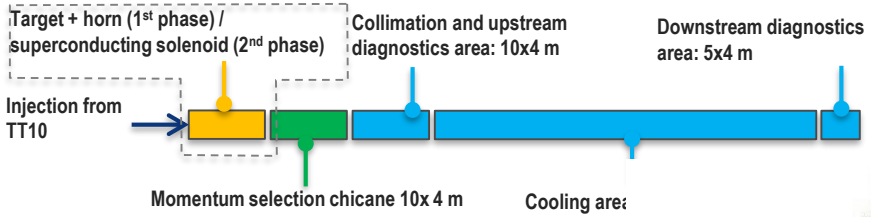


- Wide transversal tunnel offset from target & Horn leading to a bunker area.
- Vertical Handling along the beam line & access tunnel
- Equipment is supported on the ground (shielding blocks) & contained in a vessel.
- Multiple shielding blocks
- Placed inside a He vessel
- Utilities room on a separate gallery parallel to the beamline

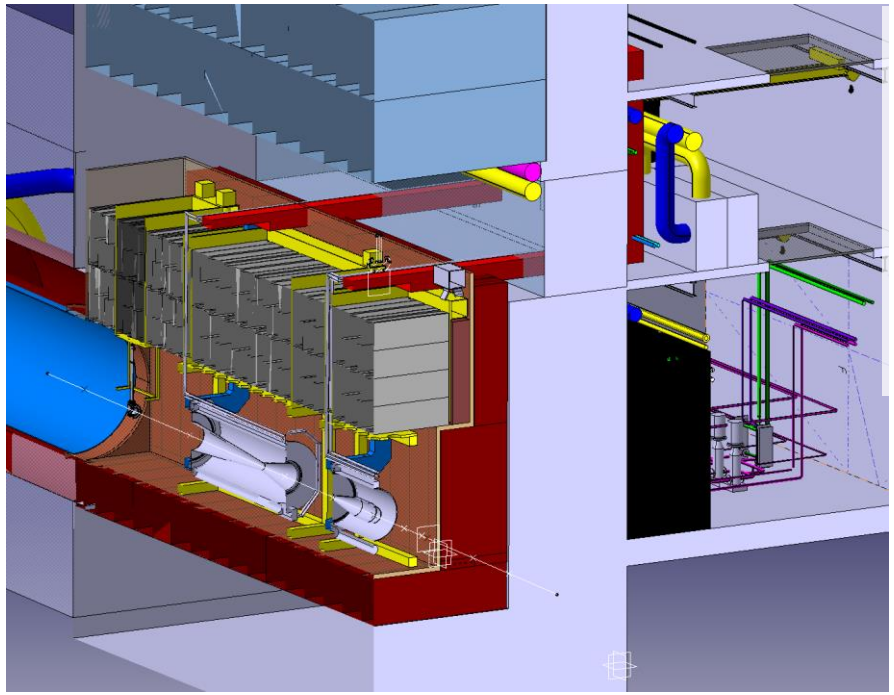


I. Efthymiopoulos, Design Study For A Future Laguna-LBNO Long-baseline Neutrino Facility At Cern, THPFI056, IPAC2013

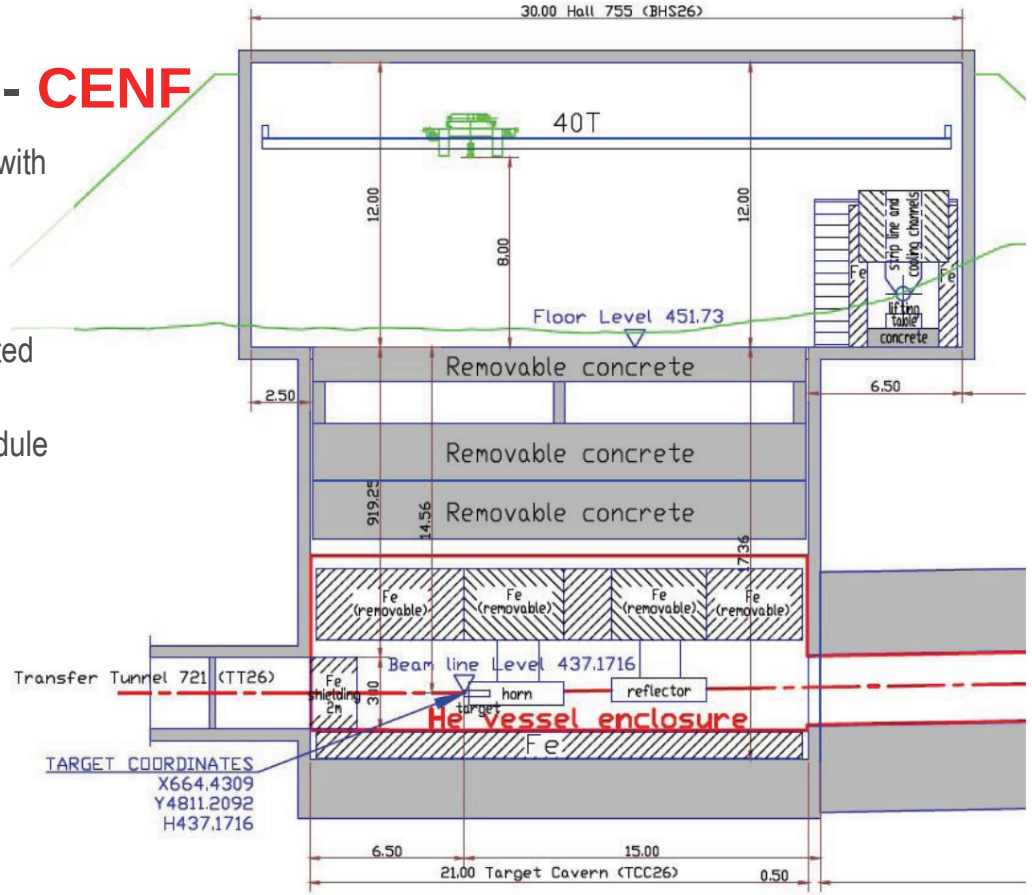
Layout ideas



Target + Horn (and/or superconducting solenoid) - CENF

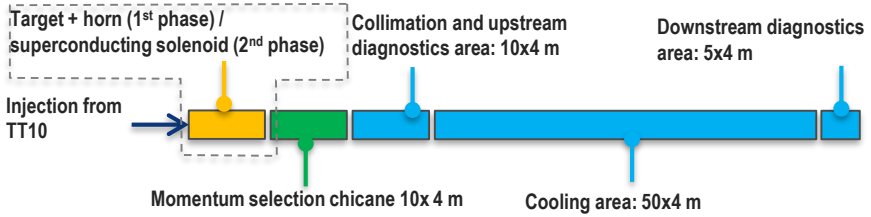


- Beam line located in a deep trench with handling made from the surface building
- Trench with fixed shielding
- Equipment on modules with integrated shielding, contained in a vessel.
- Utilities connected on top of the module to the services rooms on the side



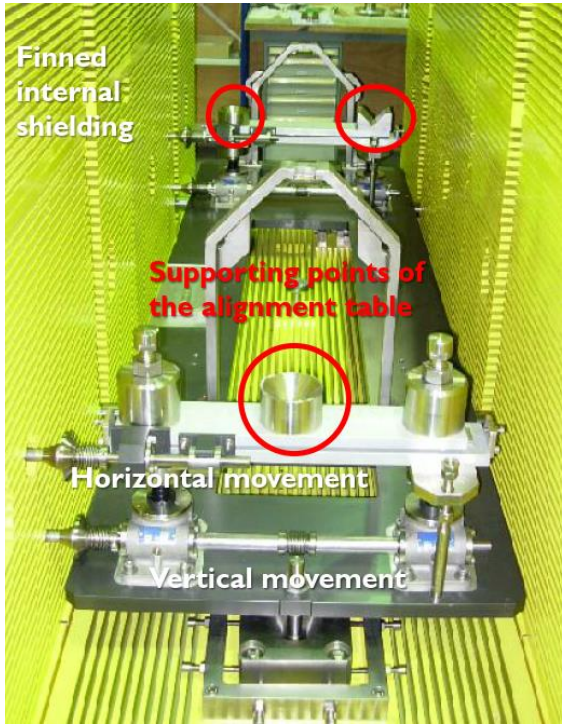
R.Steerenberg, Design Study for a CERN Short Base-Line Neutrino Facility, TUPEA052, IPAC2013

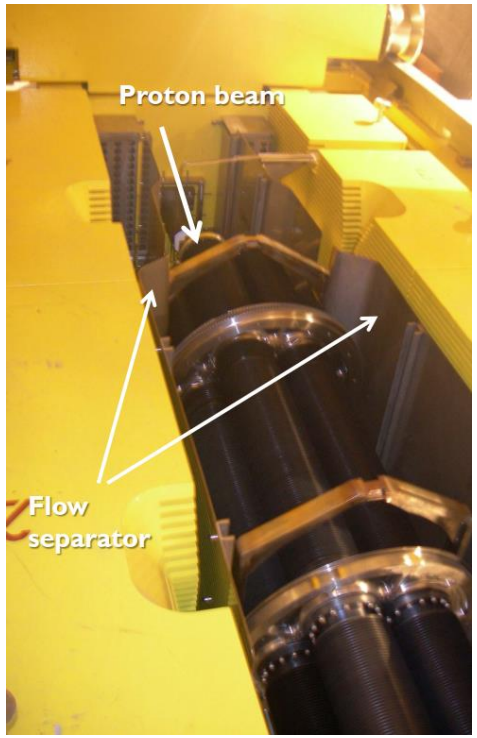
Layout ideas



Target + Horn (and/or superconducting solenoid) - CNGS

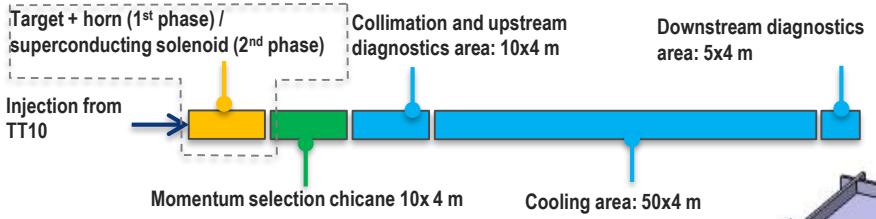
- Vertical handling with longitudinal rail system
- Target sits on a alignment table controlled laterally from the outside of the shielding.
- Shielding with fins for cooling





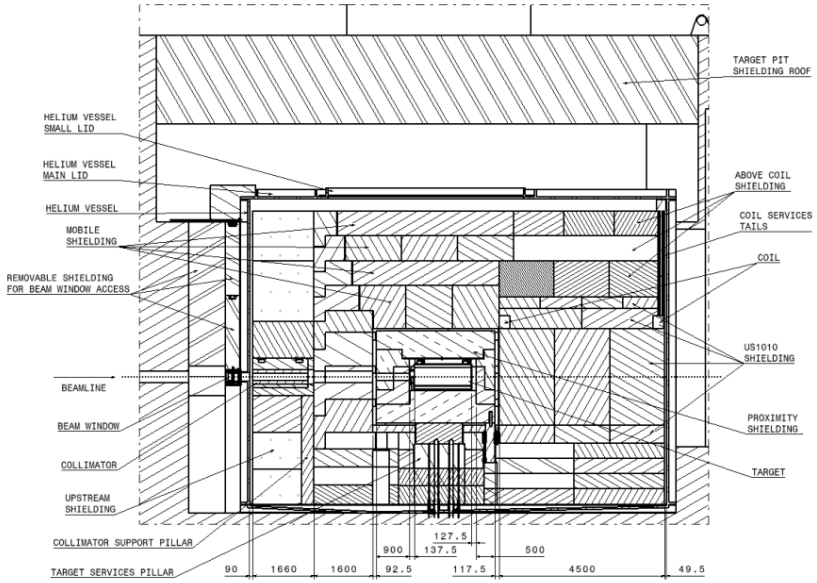
M.Calviani, Design, maintenance and operational aspects of the CNGS target, 4th HPTW,

Layout ideas

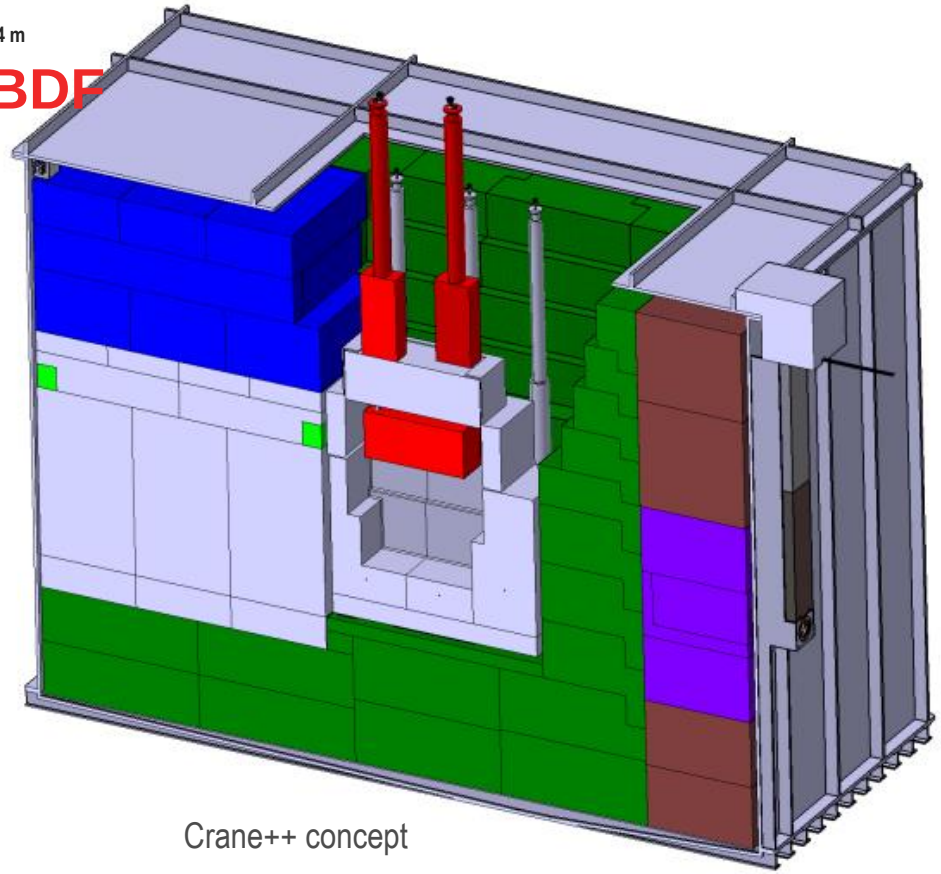


Target + Horn (and/or superconducting solenoid) - BDF

- Very detailed study thought from installation to decommissioning of the target
- Target enclosed in a shielding bunker inside a helium vessel.
- Target handled vertically with the building crane.
- Services chimneys for electrica and cooling connections of the target and proximity shielding.
- Target exchange via a shielded vessel.



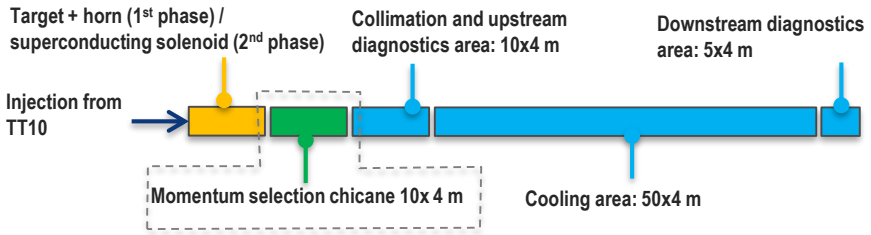
Crane concept



Crane++ concept

https://doi.org/10.23731/CYRM-2020-002

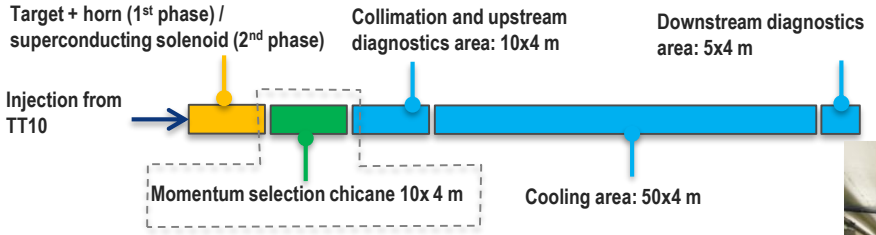
Layout ideas



Momentum selection chicane

- Chicane (“dogleg”) for momentum selection
  - What would be the momentum of the selected muons?
  - And what would be the aperture of the magnets and beam line components?
- **Can also serve as extraction to other experiments (nuSTORM / ENUBET)**
- Set of Collimator, bending magnets, quadrupole magnets and a dump.
- Highly radioactive

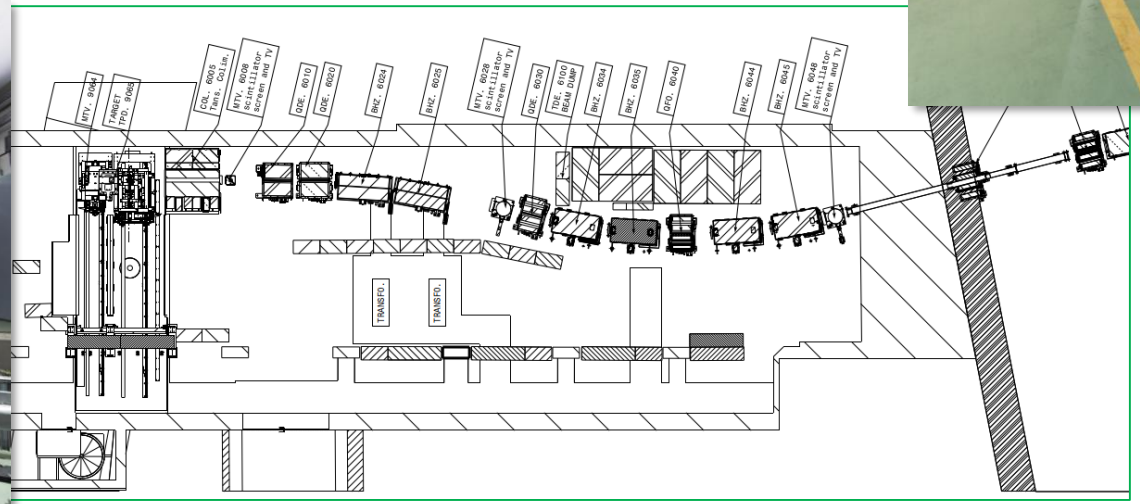
Layout ideas

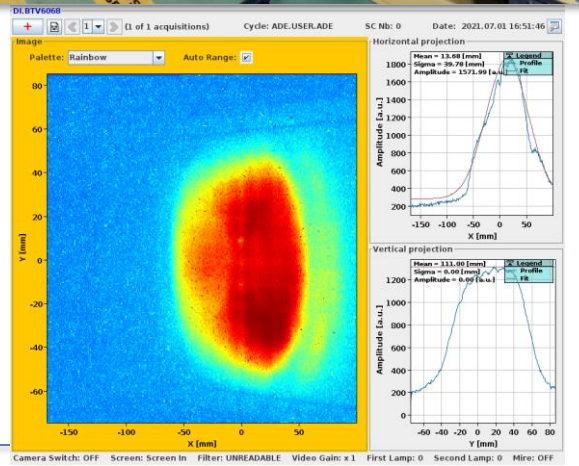


https://cds.cern.ch/record/2773294?ln=en

Momentum selection chicane – AD-Target Area @CERN

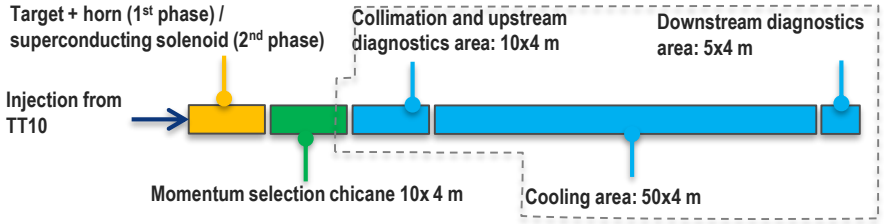
- Receives 26 GeV/c p^+ beam from PS.
- AD-T Chicane (“dogleg”) for 3.57 GeV/c momentum selection.
- How will it be for the MUC ?





BTV downstream AD-T area

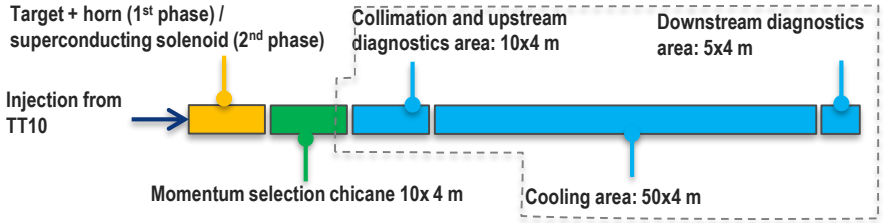
Layout ideas



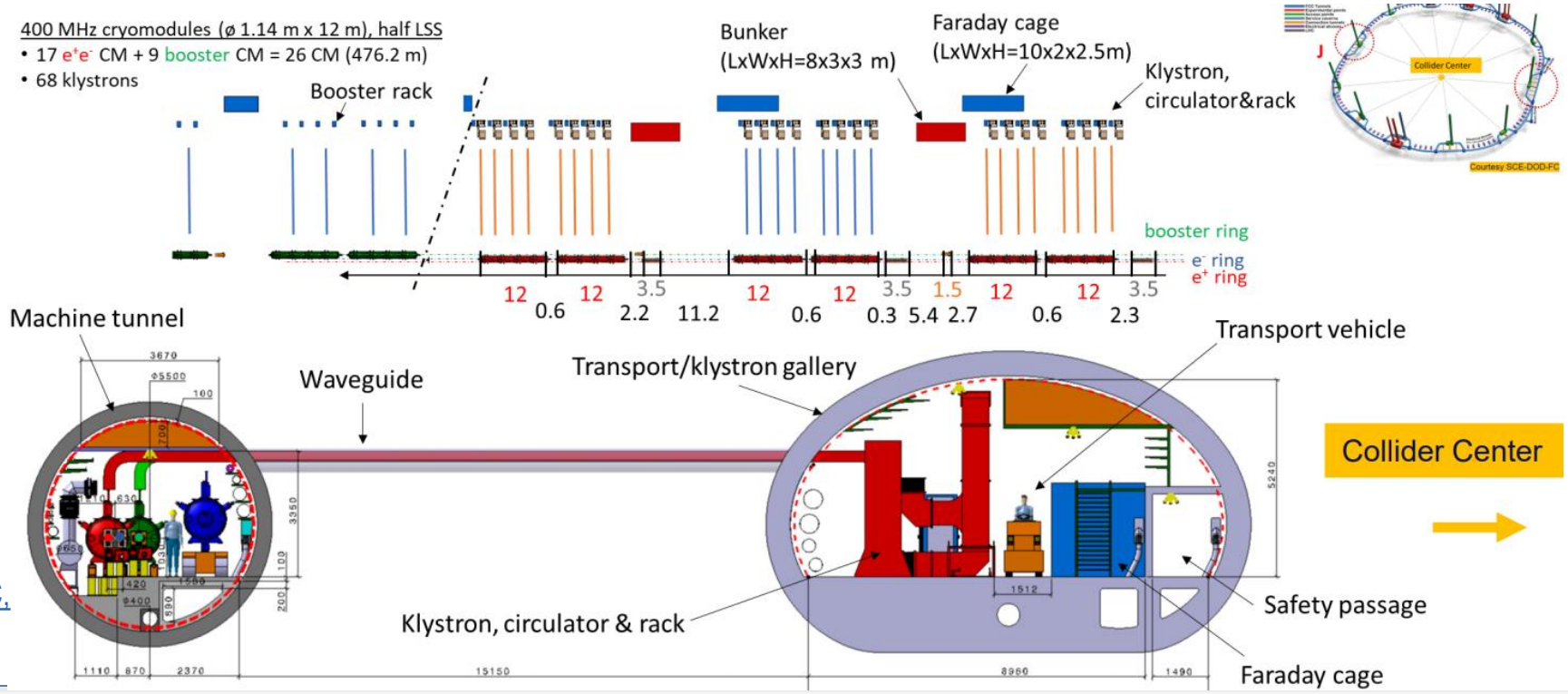
Muon Cooling Area

- Collimation & upstream diagnostics + Muon Cooling area + Downstream diagnostics area
- Collimation w/ ~5 x cryostats (Ø 2x4 m)
- Cooling w/ ~10 x cryostats (Ø 2x4 m)
- Needs a klystron area & other utilities

Layout ideas



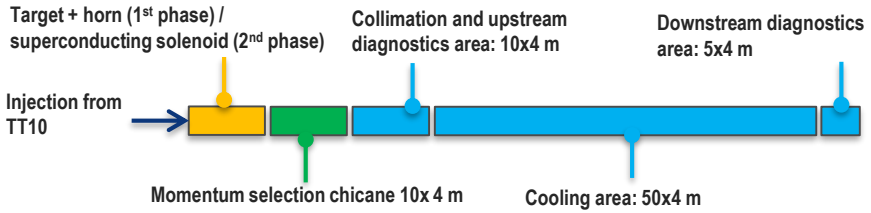
Muon Cooling Area - FCC e^+e^- Crymodules tunnel & klystrons gallery



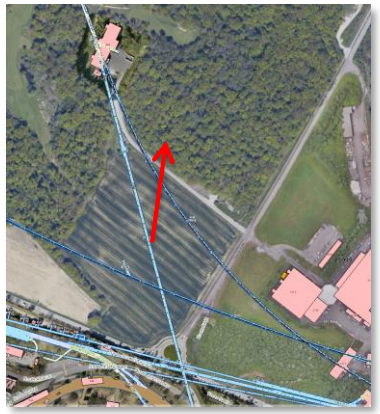
Jean-Pierre Corso, Integration of the FCC, FCC Week 2021

Conceptual layout

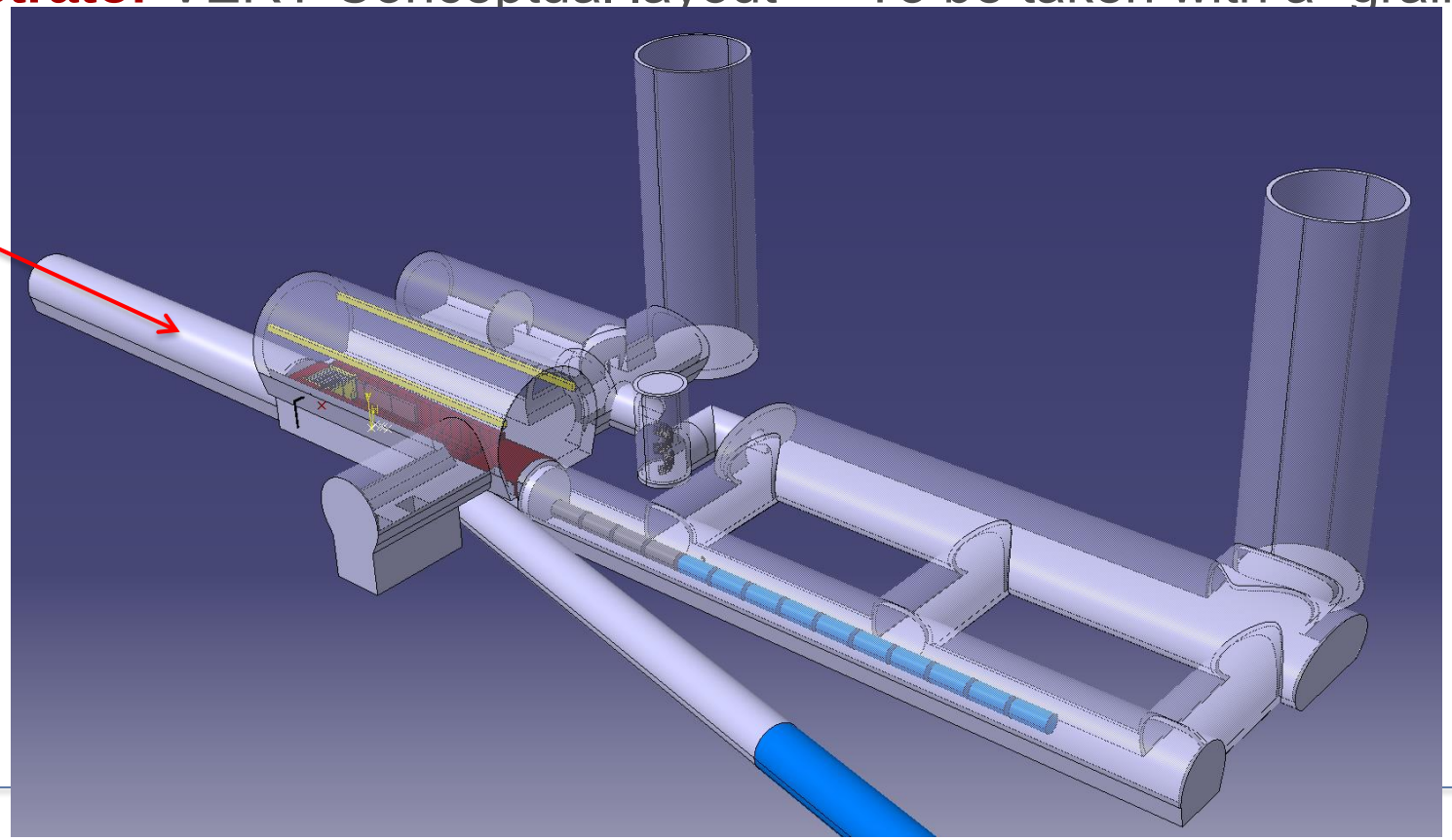
Conceptual layout



MUC Demonstrator VERY Conceptual layout → To be taken with a "grain of salt"



CERN TT10 branch



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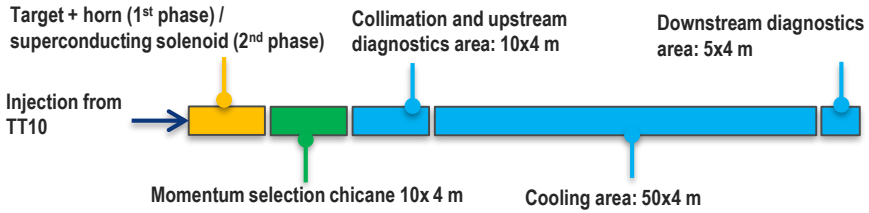

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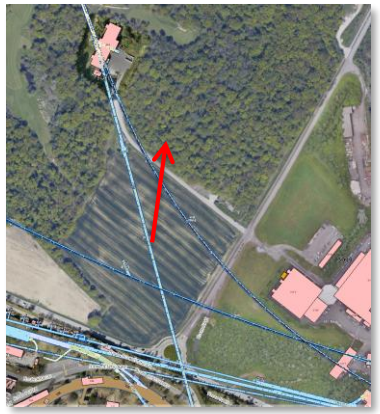

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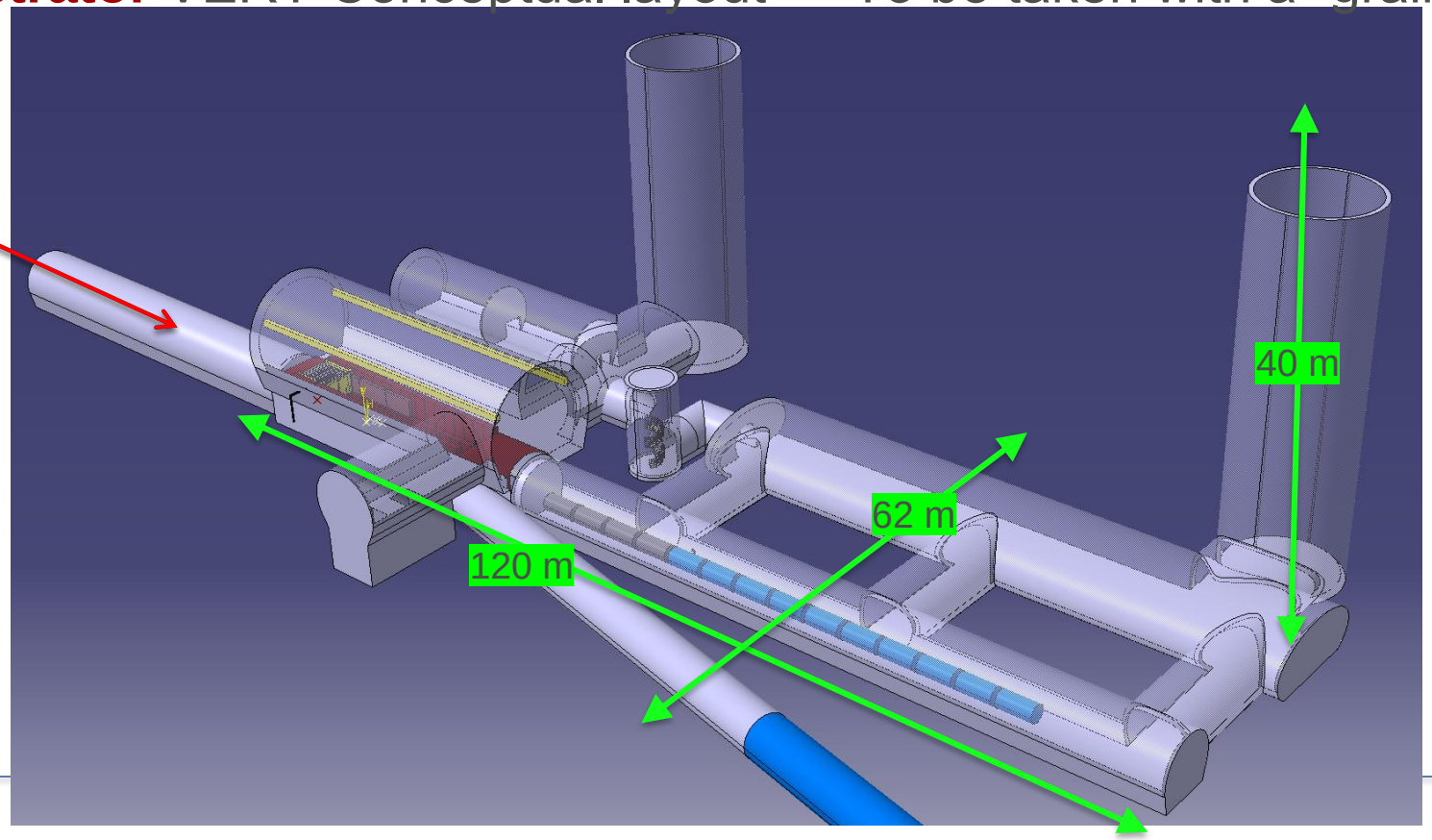
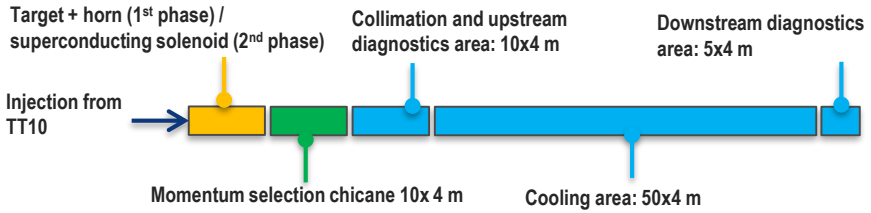


Indicative dimensions. Model is very flexible at this stage

Conceptual layout



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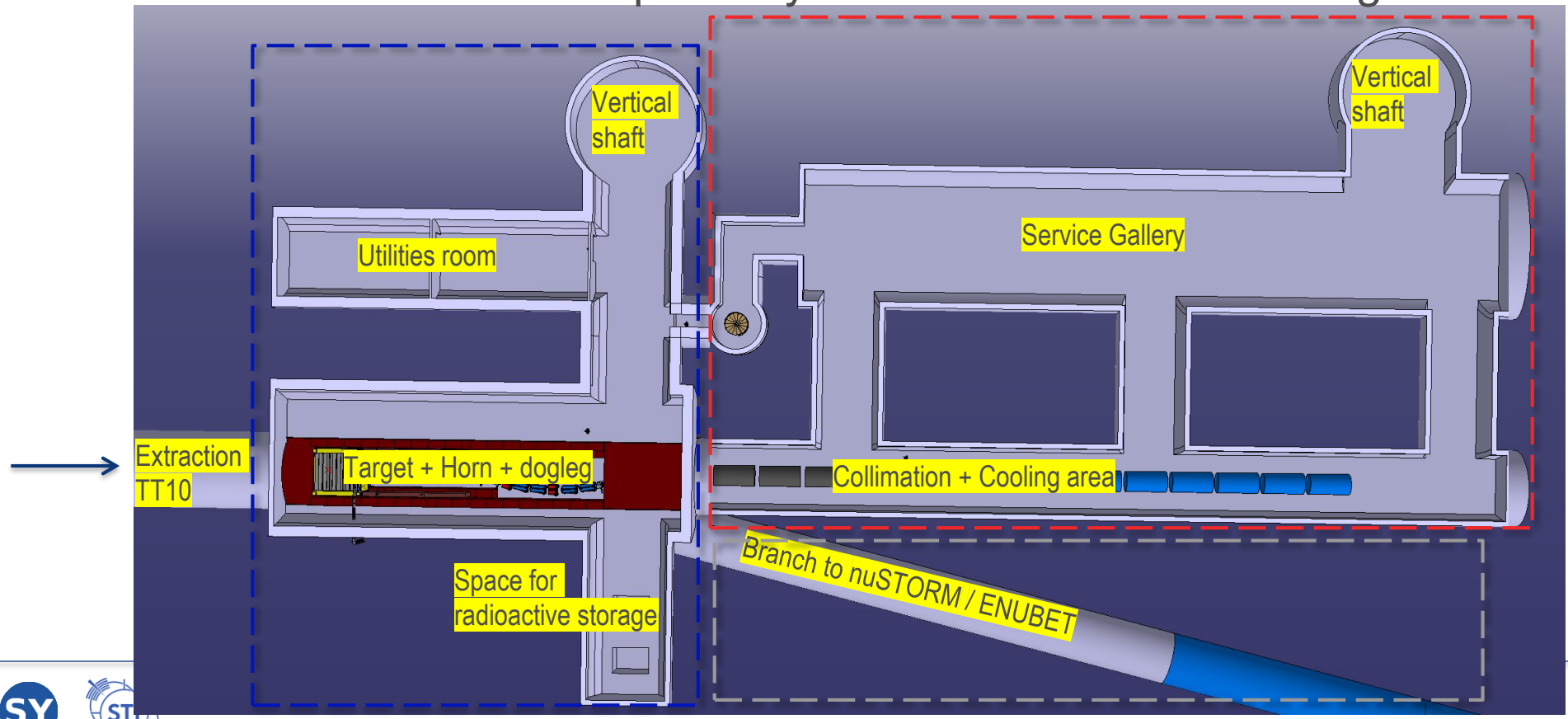

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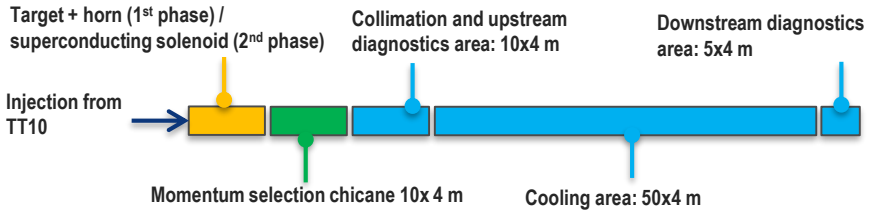

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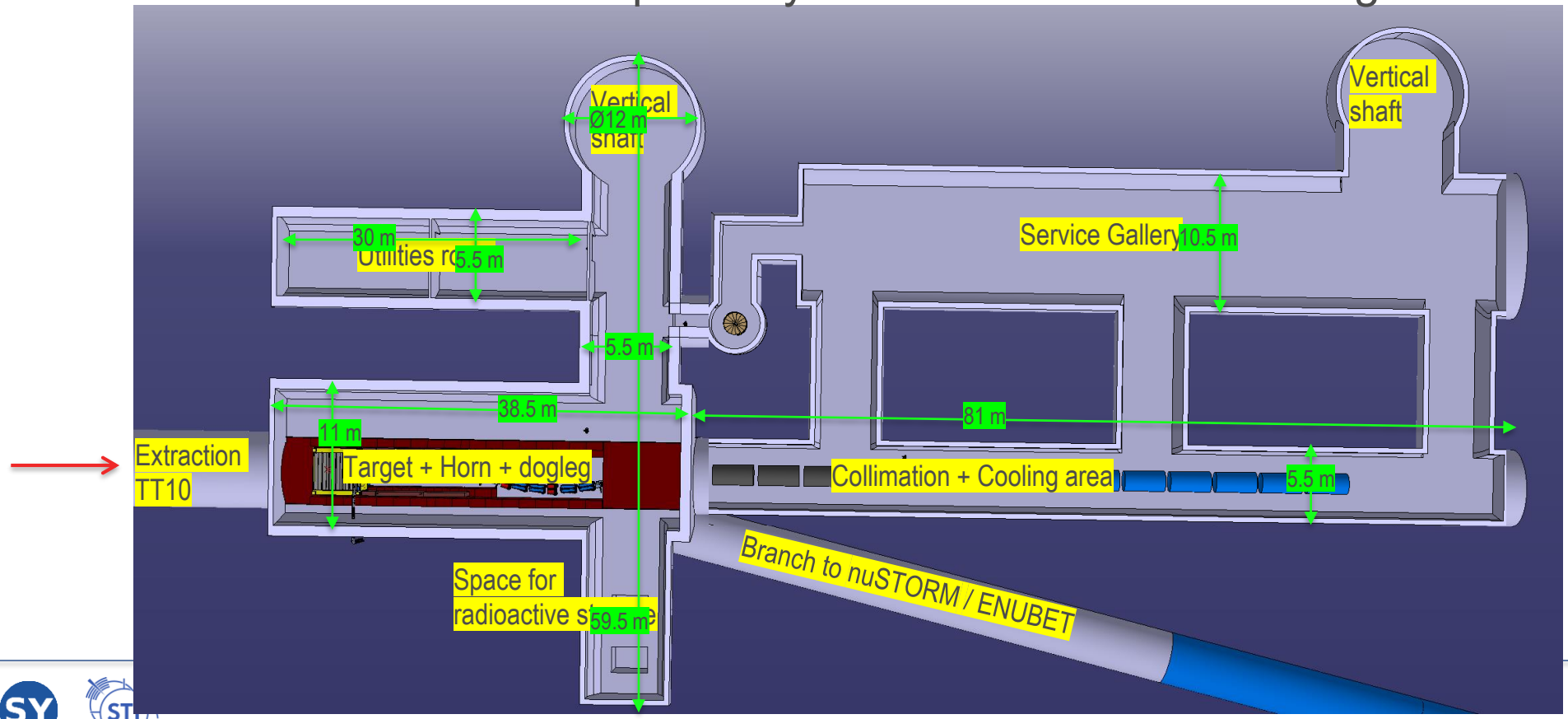

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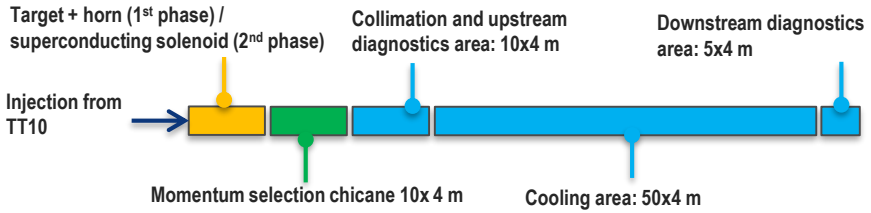

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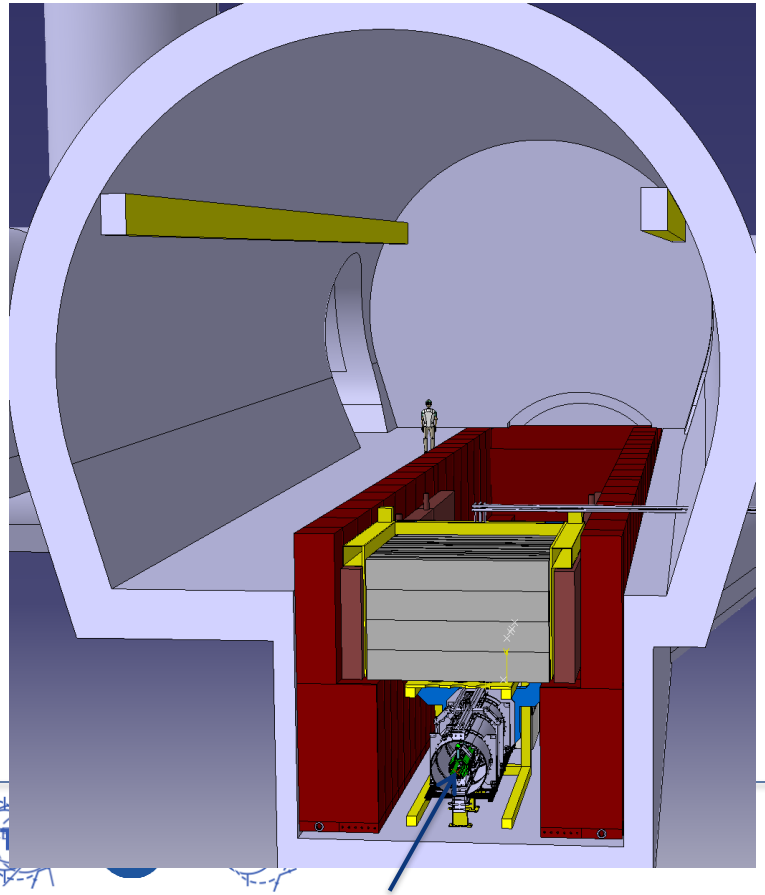
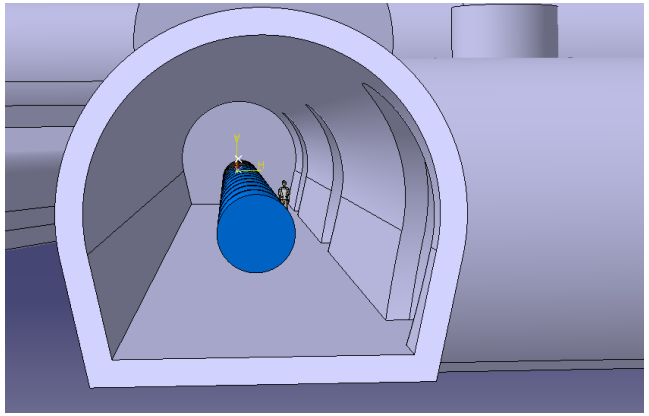
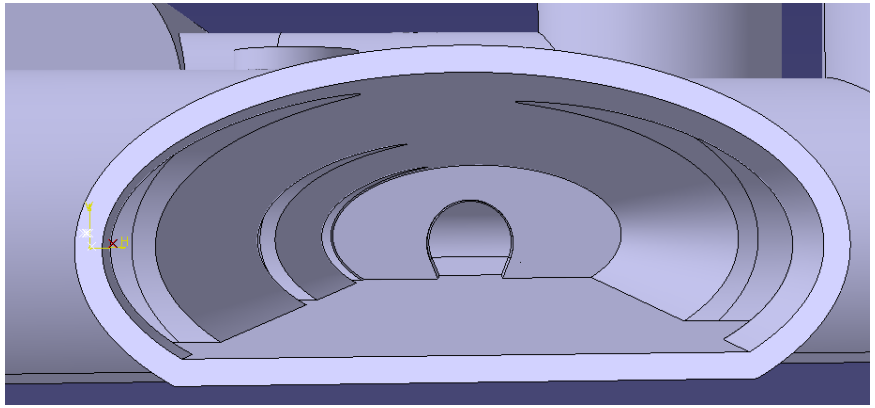


Target + Horn + chicane hall

Cooling tunnel



Services Gallery



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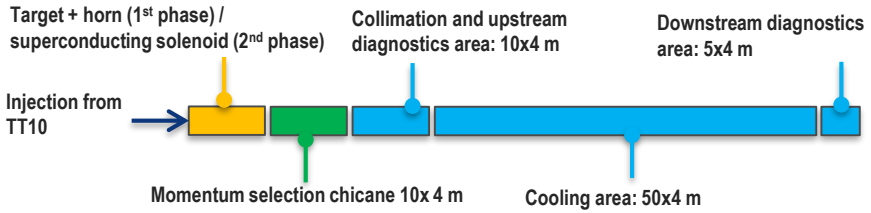

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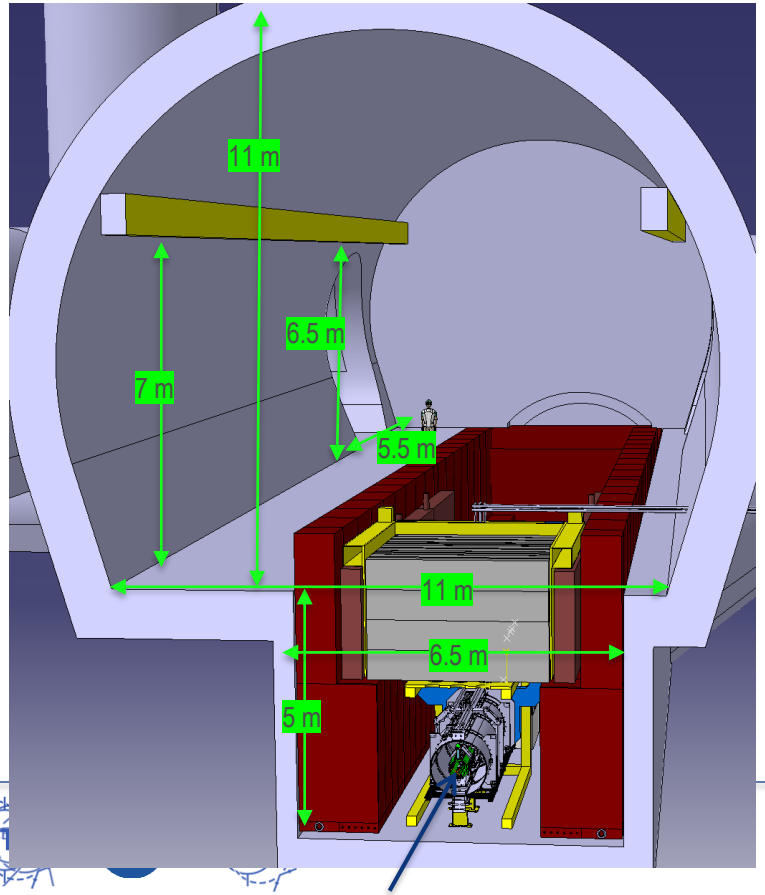
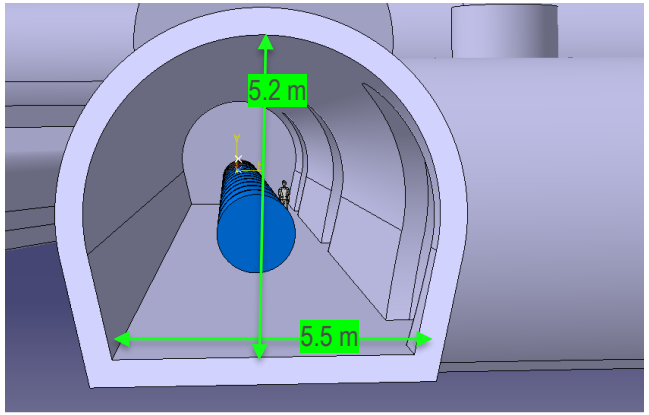


Target + Horn + chicane hall

Cooling tunnel



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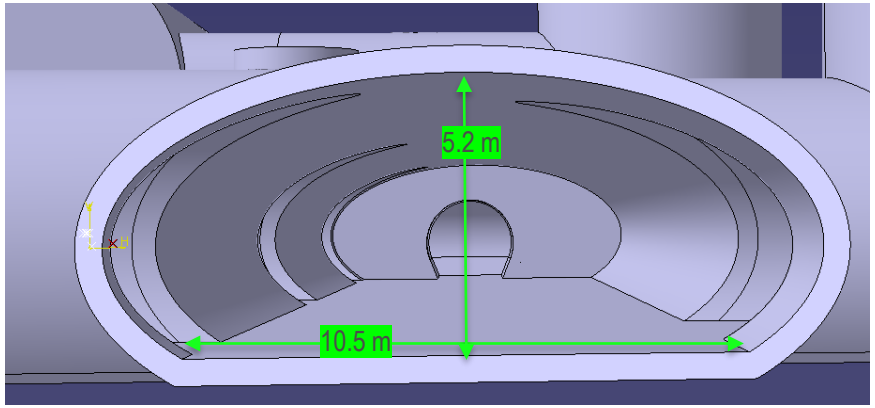

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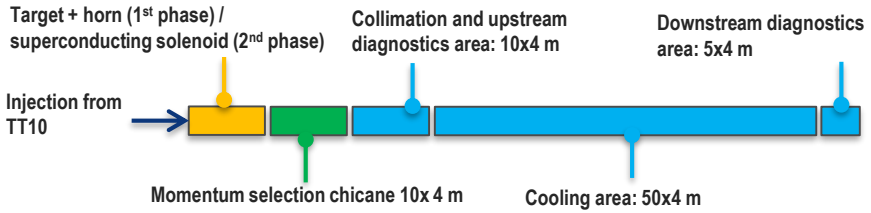
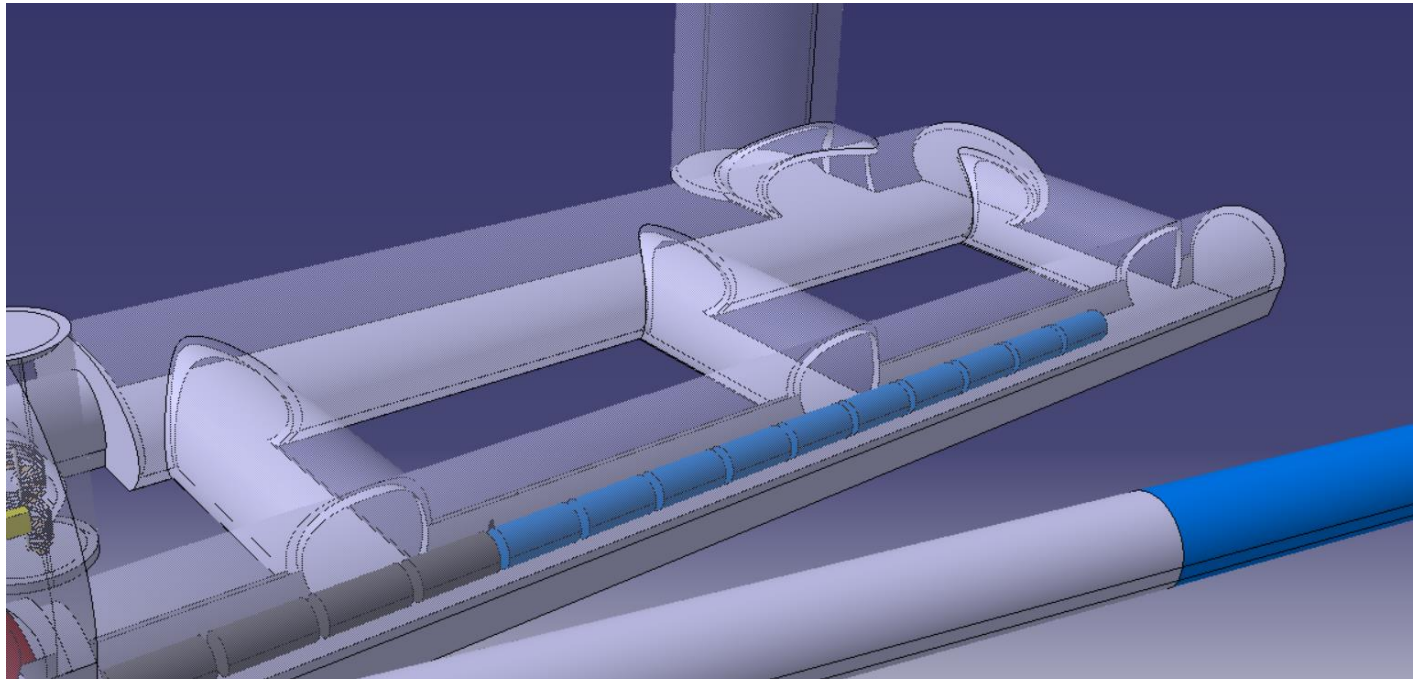
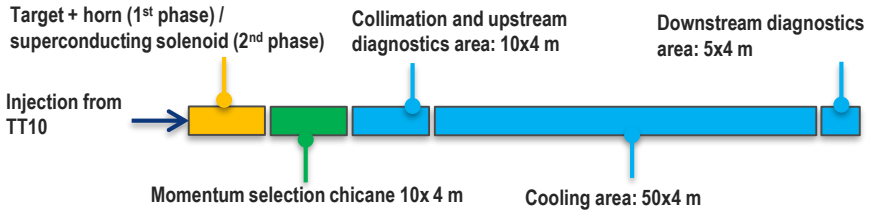


MUC Demonstrator VERY Conceptual layout → To be taken with a "grain of salt"

- Muon Cooling section can be extended if needed
- Experimental cavern (e.g. for low energy muons) can be foreseen downstream muon cooling tunnel

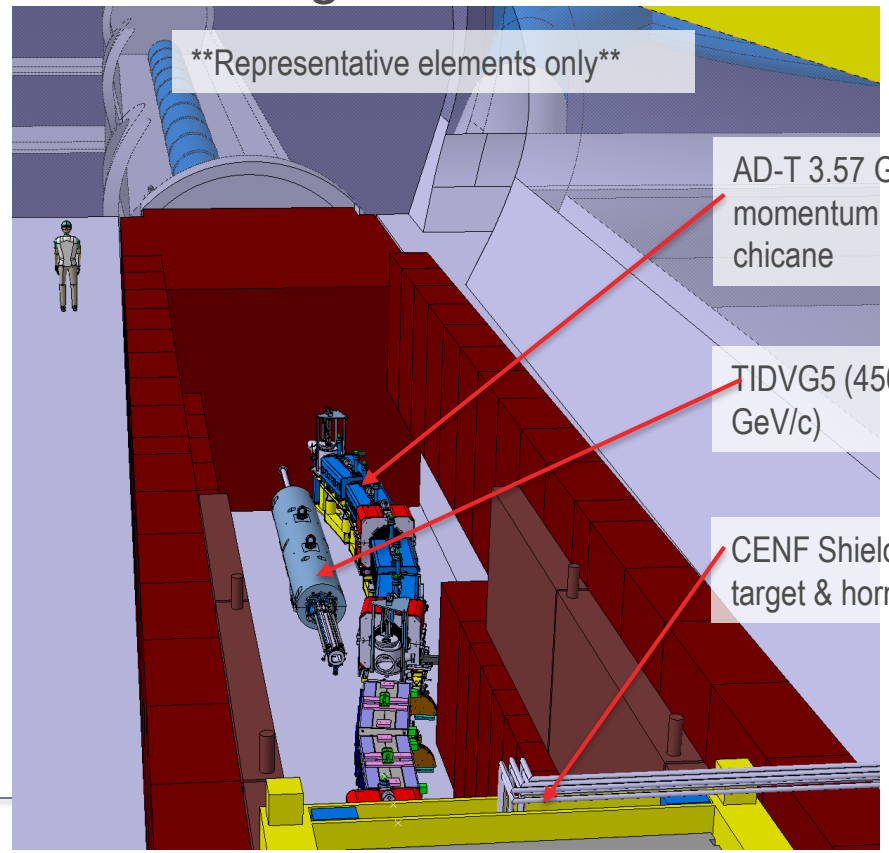


Conceptual layout

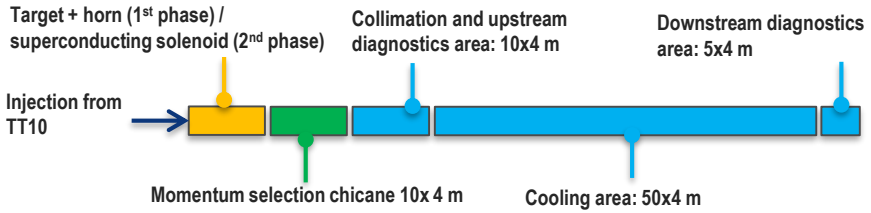


MUC Demonstrator VERY Conceptual layout → To be taken with a "grain of salt"

- Target trench like system with beam line below tunnel floor level → robust solution for radio protection
- Vertical handling with beam equipment in modules, placed in a vessel (N2) container
- Close-by radioactive storage
- Utilities in parallel gallery
- Clear separation from downstream cooling area
- **Possibility to branch to other experiments**
- Flexible facility with space accounted for future upgrades. At an early stage (80 kW), shielding may be reduced for cost optimization and could start with a simple target & horn. Flexibility to introduce more complex target systems depending on the progresses of the studies for the final Muon collider .

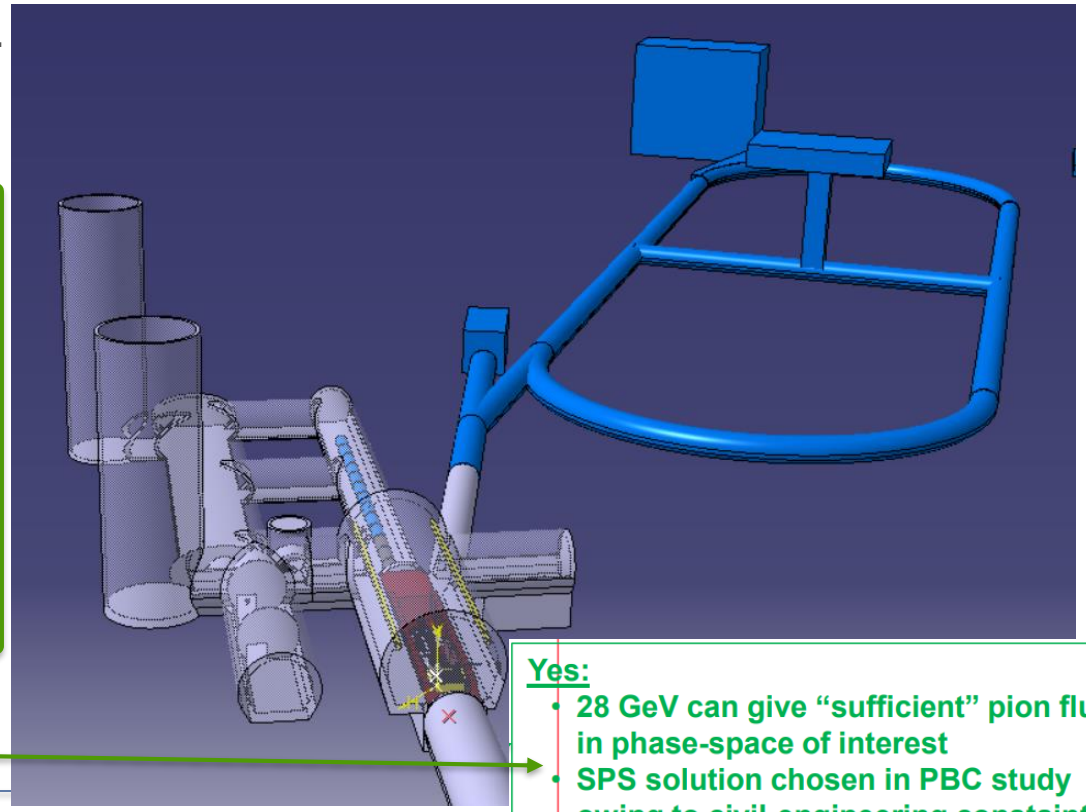


Conceptual layout



MUC Demonstrator VERY Conceptual layout → To be taken with a "grain of salt"

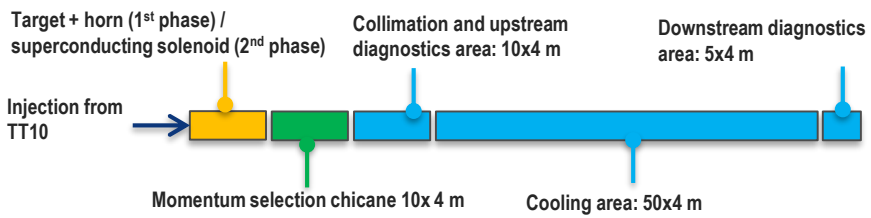
- The Facility is flexible enough to accommodate other experiments.
- nuSTORM and potentially ENUBET could be branched from the MUC Demonstrator Facility.
- The same target complex would be used profiting from its shielding and general target systems infrastructure, utilities, and accesses.
- The double deflection of the beamline could reduce radiation streaming towards the nuSTORM ring.
- Synergies between experiments would reduce costs on both sides.
- **Is the 26 GeV/c beam from the PS appropriate for these two experiments?**



Yes:
- **28 GeV can give "sufficient" pion flux in phase-space of interest**
- **SPS solution chosen in PBC study owing to civil-engineering constaints**

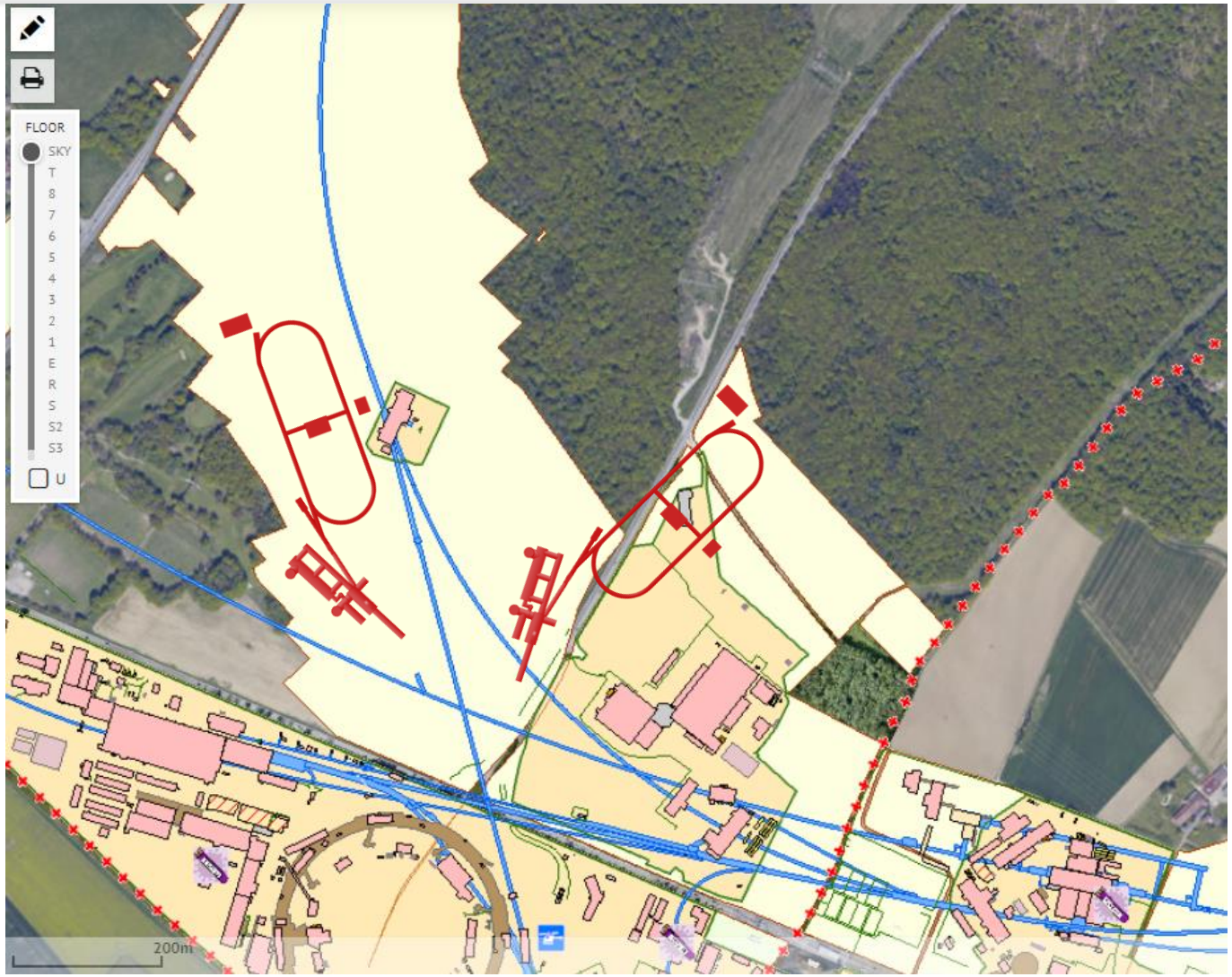
Kenneth Long @2nd MUC community meeting

Conceptual layout



MUC Demonstrator VERY Conceptual layout → ongoing:

- Currently trying to fit the facility (at least vertical shafts) within CERN domain
- Adding granularity to some of the elements & infrastructure in the layout (Target/Horn, Shielding, CE)
- SY-STI-BMI assessing particle distribution after the horn (T2K horns as inspiration)
- SY-ABT & SCE working on the beam transfer line from TT10 to the demonstrator facility.



Conclusions

Conclusions

- Supported on existing facilities and previous studies, a first MUC Demonstrator facility “concept” layout is show.
- The facility shall be flexible enough & compatible with future upgrades.
- 3D facility modelling, even if with limited degree of detail is key for costing. Important to collect all requirements at this stage in order to be able to provide a first cost estimate by end of 2021, as requested by the study
- Further inputs are needed, and early discussions with Civil engineering, RP, Transport, Cooling & ventilation, power, etc are of major importance
- Comments and feedback are welcome! e.g. sizes of components in the collimator and muon cooling part, etc
- **Possible synergies with nuSTORM/ENUBET**

Thank you for
your attention!